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Two Akentrogonid Rhizocephalans (Crustacea, Cirripedia) Parasitic on Shrimps, *Thylacoplethus edwardsi* Coutière from Japan and *T. minutus* sp. nov. from Australia

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Abstract The akentrogonid rhizocephalan *Thylacoplethus edwardsi* Coutière, type species of the genus and a parasite of the abdominal sternites of alpheid shrimps (genus *Alpheus*), is reexamined using new material from the Okinawa Islands. The externae of *T. edwardsi* from *A. gracilis* are designated as a neotype. Another and smaller species, *Thylacoplethus minutus* sp. nov. (=*Thompsonia* sp. Potts, 1915), is parasitic on the thoracal and abdominal appendages of *Synalpheus stimpsoni*. The paper describes the morphology, synonymy and distribution of the two species.
Key words: Rhizocephala, Thompsoniidae, *Thylacoplethus edwardsi*, *Thylacoplethus minutus* sp. nov., neotype designation, Japan, Australia.

The akentrogonid rhizocephalan genus *Thylacoplethus* (family Thompsoniidae) comprises small colonial parasites (externae) of simple structure. They infect a wide spectrum of crustaceans, viz., mantis shrimps, shrimps, and anomuran and brachyuran crabs. Eight species are recognized (Høeg & Lützen, 1993), of which two, *T. squillae* Høeg & Lützen and *T. orientalis* Høeg & Lützen occur in Japanese waters, parasitizing *Oratosquilla oratoria* (De Haan), *Dardanus impressus* (De Haan) and *D. arrosor* (Herbst). A specimen of a third species, erroneously identified as *Thompsonia japonica* Häfele, was illustrated by Ogawa (1995). This specimen, together with some additional material, was generously placed at our disposal by the collector, Mr. Kei-ichi Nomura, Kushimoto Marine Park Center, Wakayama, and proved to belong to *Thylacoplethus edwardsi* Coutière, type species of the genus. The material is well-preserved and allows us for the first time to examine the internal anatomy of the species with modern technique and to illustrate it.

As Høeg and Lützen (1993) tentatively suggested *Thompsonia* sp. Potts, 1915, to be a synonym of *T. edwardsi*, we have reexamined Potts' original specimens. Comparison with the new material has convinced us that it represents a different species, which we have named *Thylacoplethus minutus* sp. nov.

Materials and Methods

The following material was examined: 1) One male *Alpheus gracilis* Heller, carapace length 7.9 mm, infected with 45 externae, from the reef of Yakabi Island of the Okinawa Islands, Ryukyu Archipelago, on 26 April, 1994. 2) Three of 52 externae infecting one specimen of an undescribed species of *Alpheus* sp. (aff. *staphylinus*), carapace length 9.0 mm, from the coast of Yakabi Island, 15 m depth, on 4 July, 1993. The material was collected during a faunistic survey of the Kerama Group (see Nomura *et al.*, 1996). Two externae, each from each host, were embedded in araldite following detachment from the host. They were cut into cross and longitudinal 2 μm thick serial sections, and stained with toluidine blue. 3) More than 60 externae infecting a specimen of *Synalpheus stimpsoni* (De Man), carapace length 7.8 mm, from Murray Island, Torres Strait, northern Australia (deposited at the Natural History Museum, London). The specimens were identified as *Thompsonia* sp. by Potts (1915).

The material of *T. edwardsi* is deposited in the National Science Museum, Tokyo (NSMT-Cr 12134, neotype on *A. gracilis*, and NSMT-Cr 12135, one externa taken from *Alpheus* sp.). The examined specimen of *T. minutus* sp. nov. is selected as a type specimen and catalogued as no. 1997.2023 at the Natural History Museum, London.

Results

1. The specimens parasitizing *Alpheus gracilis* and *Alpheus* sp. (Figs. 1, 2 A, 3)

External description. All externae from each shrimp are about equally large and represent the same stage of development. The externae of the *A. gracilis* parasite contain early embryos and are whitish. Those of the other host are of a faintly grayish shade caused by their contents of advanced embryos with pigmented paired composite eyes.

The externae from *A. gracilis* are slightly club-shaped, distally evenly rounded. Five specimens measure 2.9–3.5 mm in total length, with the greater diameter (0.85–0.92 mm) occurring in the distal half. The basal 1/6 to 1/7 of the body tapers regularly and terminates in a small, shining annulus (a^1) with a diameter of ca. 150 μm. This part of the body corresponds to the stalk, or peduncle, in other thompsoniids and is distally delimited by another, much wider annulus (a^2, diameter 525–550 μm) with a slightly sinuous course. The externae are in an early phase of moulting and in most places the exterior cuticle (c^2, Fig. 3) has detached from the future and final interior cuticle (c^3). All along the distal annulus, however, the two cuticles are firmly fused.

The three externae from *Alpheus* sp. are also club-shaped, but relatively more elongate than the younger ones from *A. gracilis*. They measure 3.4–4.1 mm in length and 0.90–1.00 mm in diameter. The exterior of the two cuticles has detached from the

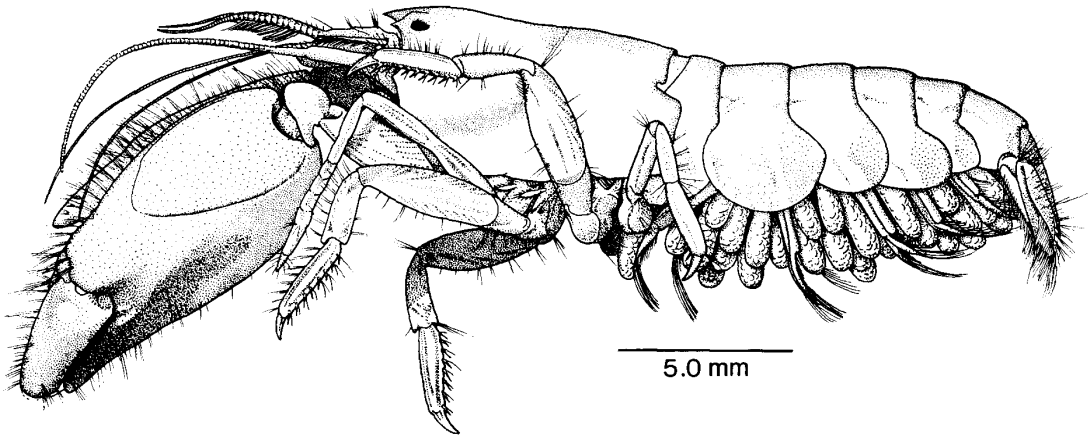

Fig. 1. Male of *Alpheus gracilis* Heller, parasitized on its abdomen by 45 externae of *Thylacoplethus edwardsi* Coutière (neotype). Yakabi Island of the Okinawa Islands, Ryukyu Archipelago, Japan. Drawn by Beth Beyerholm.

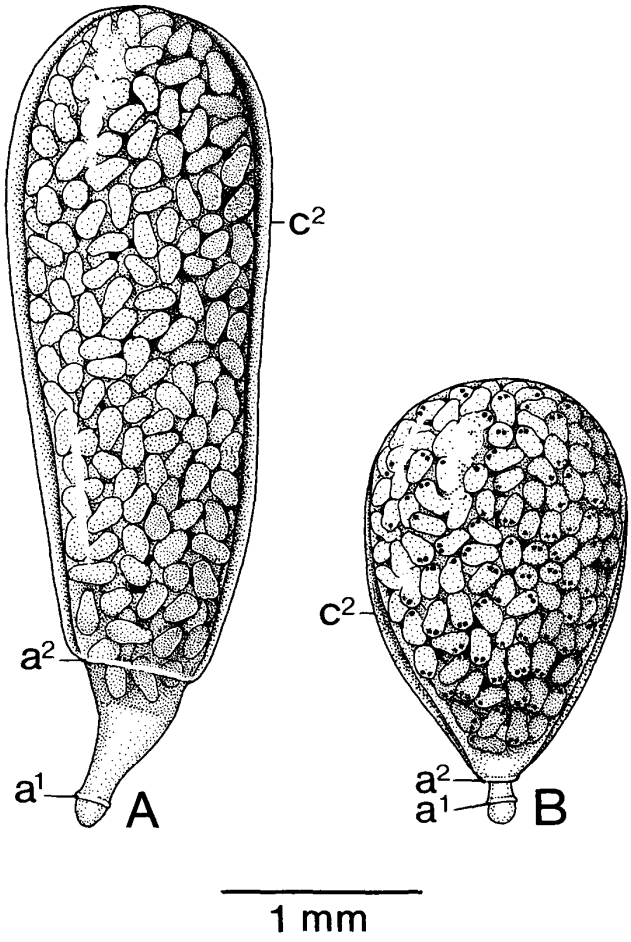

Fig. 2. A, externa from neotype of *Thylacoplethus edwardsi* (from *Alpheus gracilis*); B, externa of type-specimen of *T. minutus* sp. nov. from *Synalpheus stimpsoni*, Murray Island, northern Australia. a^1 and a^2, annuli; c^2, cuticle. Drawn by Beth Beyerholm.

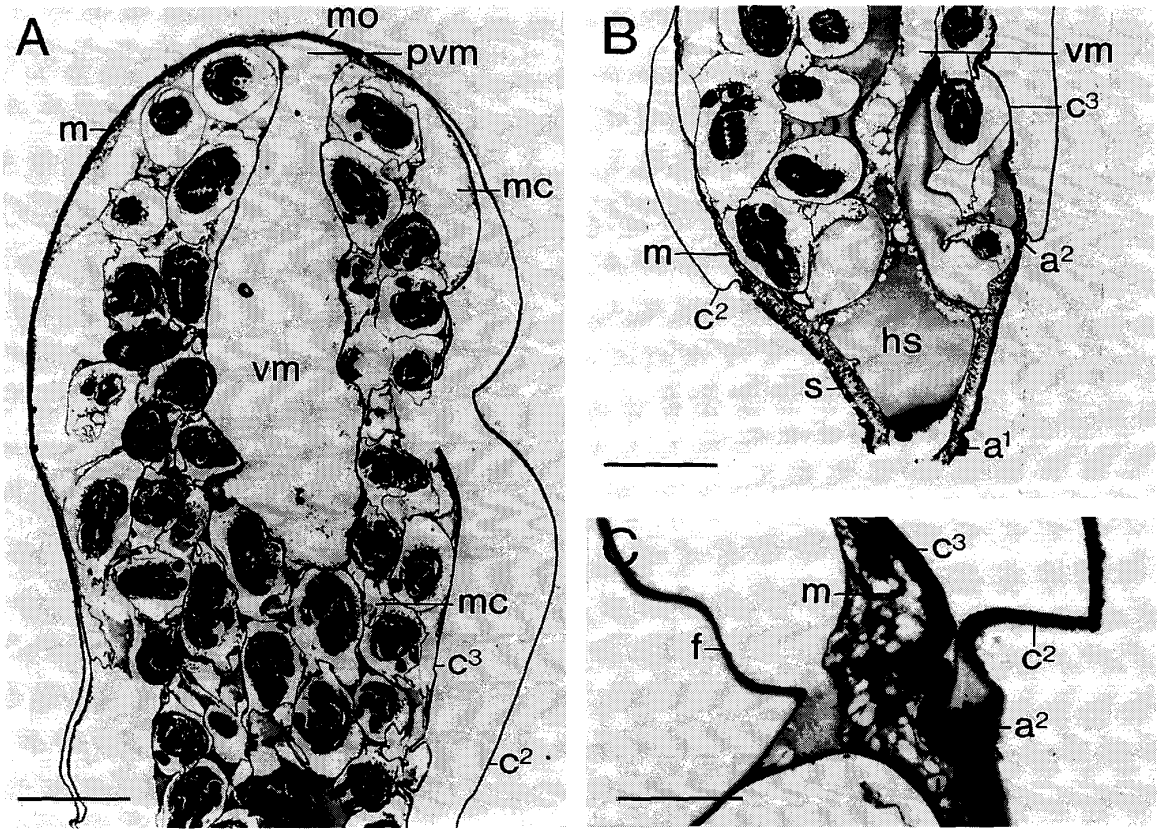

Fig. 3. *Thylacoplethus edwardsi*. Longitudinal sections through an externa from *Alpheus gracilis*. A, terminal part; B, basal part; C, detail of upper part of stalk region. a^1, small basal annulus; a^2, wide distal annulus; c^2 and c^3, cuticle 2 and 3; f, fertilization membrane; hs, haemal sinus; m, mantle; mc, mantle cavity; mo, prospective mantle opening; pvm, plug-shaped part of visceral mass; vm, visceal mass; s, stalk. Scale bars: 200 μm (A and B) and 25 μm (C).

interior one everywhere except along the wider of the two annuli and at the distal pole.

Internal morphology of both stages are essentially the same (Fig. 3). The spacious mantle cavity is filled with embryos each surrounded by a fertilization membrane. In longitudinal and transversal sections an irregularly cylindrical visceral mass issues from the stalk region and runs as a club-shaped structure the entire length of the mantle cavity. Apically the visceral mass, almost devoid of any tissue including ovarian tissue, fits as a plug into a ca. 185 μm broad circular opening in the mantle wall. The mantle is very thin, except in the stalk region where a tall cylindrical epithelium underlines a relatively thick cuticle. This cuticle is single, but distally to the wide annulus, the mantle is enveloped by two cuticles, that have more or less separated from one another, but are still connected along the distal annulus and at the terminal pole of the body. From a study of moulting in other thompsoniids we know that each cast cuticle leaves a distinct annulus in the stalk region (Høeg & Lützen, 1993).

The small, basal annulus is therefore what remains of the first, shed cuticle (c^1), whereas the exterior of the two above-mentioned cuticles represents the next cuticle (c^2) and the interior one the final cuticle (c^3). When c^2 is later cast and the visceral mass shrinks and shortens, a circular opening is formed which allows the cyprinids to escape from the mantle cavity.

No traces were found of oviducts, which are present in a rudimentary state in some species of *Thylacoplethus*. In this genus, spermiogenesis takes places within the ovary, but this is only demonstrable before oviposition.

2. The specimens (=*Thompsonia* sp. Potts) parasitizing *Synalpheus stimpsoni* (Fig. 2 B)

External description. All specimens are elongated oval or pear-shaped with the largest diameter occurring in the distal third of the body. Total length varies between 1.2 and 2.2 mm, and maximum diameter between 0.9 and 1.35 mm. The stalk is very short with two close-set annuli (a^1 and a^2) of equal diameter. No other annuli could be found. A mantle pore is absent, but was observed by Potts (1915, Fig. 5) to appear in later stages as circular distal opening.

Remarks

The specimens from *Alpheus gracilis* and *Alpheus* sp. match the amended diagnosis of *Thylacoplethus* by Høeg and Lützen (1993), even if, certainly because of the advanced development of the externae, paired oviducts and spermatogenic tissue could no longer be traced. The complete absence of ovarian tissue in the visceral mass indicates that the externae spawn only once. A hemispherical termination of the stalk fitting a depression in the host cuticle was not demonstrated, as this requires sectioning of the externae *in situ*, but such a structure was observed and described by Coutière (1902) and therefore has been sketched in Fig. 2 A.

Coutière (1902) did not illustrate his specimens of *T. edwardsi* from *A. edwardsii* (Audouin) and *A. sulcatus* Kingsley [*A. macrochirus* (Richters) according to Coutière, 1902]. He established a separate species, *T. haddoni*, for the parasites of a specimen of *A. strenuus* (Dana) [*A. avarus* (Fabricius) according to Coutière, 1902] but they clearly simply represent earlier stages of *T. edwardsi*. Our specimens differ from other species of *Thylacoplethus* by the conical shape of the stalk portion, delimited by two widely separated annuli, a small basal one and an extraordinarily wide distal one. In other species the two annuli are both small and rather close-set. Only the basal annulus was noted by Coutière (1902), but we believe the other one was overlooked (which we almost did) rather than absent in his specimens. Except for this, our material matches that of Coutière (1902) reasonably well. On three hosts he recorded 70–120 externae, which were ovoid when small (1.5×0.5 mm), but when larger had elongated to a maximum length of 4.5 mm. More than 55 club-shaped specimens from a northern Taiwanese *A. sulcatus* from a photograph provided by Dr. Tin-Yam Chan, National Taiwan Ocean University, Keelung, also show a close simi-

larity in shape with our material. Additional specimens from Taiwan sent to one of us (JL) had unfortunately desiccated at arrival and could not be examined. As Coutière's original sample has apparently vanished (information from Museum National d'Histoire naturellae, Paris), we have selected the externae from *A. gracilis* as a neotype.

One of our infected specimens (*Alpheus* sp.) is identical with the one illustrated by Ogawa (1995) who erroneously identified the parasites as *Thompsonia japonica*. *Alpheus gracilis* is a new host.

Høeg and Lützen (1993) surmised that the specimens of *Thylacoplethus* from shrimps might comprise at least two species. All parasites of species of the genus *Alpheus*, including ours but except *A. malleodigitatus* (Bate, 1888), are exclusively attached to the abdominal sternites. Specimens from three other shrimps, *A. malleodigitatus* (Bate), *Synalpheus stimpsoni* (De Man) and *Lysmata dentata* (De Man) preferably attach to the thoracic and/or abdominal appendages, rarely to the pleura of the abdomen, but never to the sternites (Bate, 1888; Potts, 1915; Høeg & Lützen, 1993). Of these parasites only Potts' specimens ("*Thompsonia* sp.") from *Synalpheus stimpsoni* (Potts: *S. brucei*, a nomen nudum) are reasonably well known. Our reexamination has shown Potts' description to be fairly accurate except that he did not note the presence of the two small and close-set annuli. They are, however, shown in one of his illustrations (Potts, 1915, Fig. 5) and are also evident in a specimen sectioned by Høeg and Lützen (1993, Fig. 11). Potts' specimens clearly differ from the new material of *T. edwardsi* in size and shape of the externae, and in the diameters of, and distance between, the two annuli; they are furthermore located on other parts of the host body than *T. edwardsi*. It is therefore inevitable to conclude that they represent a distinct species, which we have named *Thylacoplethus minutus* sp. nov. The synonymy, diagnoses and distribution of the two species are as follows:

Thylacoplethus edwardsi Coutière, 1902

Thylacoplethus edwardsi Coutière, 1902: 625.
Thylacoplethus haddoni Coutière, 1902: 625.
Thylacoplethus edwardsi: Høeg & Lützen, 1993: 374 (in part).
Thylacoplethus japonica Ogawa, 1995: 135, pl. 78, fig. 5.

Externae club-shaped, up to 4.5 mm long, largest diameter occurring in distal half. With two annuli placed far from each other, the basal one small, the distal one very wide.

Attached to the abdominal sternites of species of *Alpheus*.

Distribution: Indo-Pacific from Mozambique (Bay of Fernao Veloso) through the Torres Strait and coast of Queensland (Thursday Island) to northern Taiwan and the Okinawa Islands (Yakabi Island).

Thylacoplethus minutus sp. nov.

Thompsonia sp. Potts, 1915: 3.
Thylacoplethus edwardsi: Høeg & Lützen, 1993: 374, Figs. 10–11.

Externae oval to pear-shaped, up to 2.2 mm long. With two close-set basally located annuli.

Attached to the thoracal and abdominal appendages of *Synalpheus stimpsoni*.

Distribution: Northern and eastern Australia (Murray Island and Lizard Island).

Etymology: The specific name comes from Latin *minuere*, to diminish, a reference to the small size of this shrimp-infesting parasite.

Although Bate's specimens are similar to *T. minutus* sp. nov. in shape and mode of attachment (to the pleopods of its host), they are very insufficiently known. Bate's short description does not allow us to decide whether a circular mantle opening is absent or present, *i.e.*, whether his specimens belong to *Thompsonia* (if absent) or to *Thylacoplethus* (if present). The parasites from hippolytid shrimp *Lysmata dentata*, mentioned by Høeg and Lützen (1993) are also too poorly known to be assigned to any of the two named shrimp-infesting species.

The morphological simplicity of the thompsoniid externae makes it extremely hard to distinguish between species. Huang and Lützen (1998) succeeded in clearly distinguishing between three morphologically similar species of *Diplothylacus*, another thompsoniid, by minute but constant differences in size and microanatomy of the cyprinid larvae. Close description of size, antennules, carapace and other details should therefore be given, whenever cyprinid larvae are present in the material.

Acknowledgements

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